THE
TELEGRAPHIC JOURNAL.

VOL. IV. APRIL 1, 1876. No. 76.

UNDERGROUND AND OVERGROUND TELEGRAPHS.

DECIDEDLY the question of underground versus overground wires is growing to a head. The severe test that our overburdened telegraph poles have been put to by the weather resulting in great gaps being made in important lines, the delay to the special train carrying the Empress of Austria on the Great Western through the fall of telegraph poles across the permanent way, and finally the accidents in the metropolis, through the breaking of overhead wires, have all served to draw public attention to the matter. The press have frequently alluded to it, and even in the House of Commons the subject has cropped up, and Lord John Manners hinted, in answer to a question, that subterranean lines would be more employed in future than they hitherto had been.

We have been so long accustomed to considering overground wires, in the country at least, as the best and only way of constructing telegraphs, that the idea of subterranean wires only comes to the front now and then, when the question is prominently thrust before the public by the interruptions caused by the overground system failing seriously, in spite of the numerous routes which our great network of telegraphs gives between any two important towns. These great interruptions have, however, become more frequent, although they occur, we admit, at considerable intervals. But if we consider that wires have constantly to be added to the poles, which, although scarfed and repaired at times, must on the whole be constantly growing weaker, it is certain that these interruptions must become more and more frequent. On some lines there are 18 or 20 wires on one set of poles, and on the Great Eastern line, near London, the wires nearly touch the railway embankment, from the number that have been placed on the poles. On many lines telegraph poles run on each side of the railway, and soon, therefore, a third set of poles would have to be erected.

The telegraph lines on the railways are maintained by the railway companies at so much per mile for the Government. Who these lines belong to it is difficult to say. They were erected by the telegraph companies, and the Government paid the telegraph companies for them; but if the Government wished to remove them, we suppose they could not do so, even if they were worth taking down.

If the Government require more wires, they can obtain them by paying the railway companies, or they can go along the high roads. This they do to a great extent, but principally by overground lines. Now if overground wires are bad along railways, they are ten times more objectionable along high roads, at least in a mechanical and electrical point of view. A railway, with its straight lines and easy curves, is well adapted for overground lines; but our tortuous English lanes and roads, with trees and hedges, are excessively ill adapted for this purpose. Sharp turns at right angles have to be made, which the ordinary insulators that can be used on straight lines or easy curves cannot stand, and therefore shackles, giving less perfect insulation, have to be employed. Again, even the poles are subject to considerable strain, even with only one or two wires, at these sharp angles, and the staying of them is difficult, as the poles have to be kept clear of the road, and are thus thrust close to the hedges, whilst even to get a stay into a ploughed field the permission of some landowner has to be obtained. Trees have naturally to be avoided if possible, and when even to save great strain on the poles it is desirable to cut a corner off, a wire has to hang over private property. In the case of trees, permission has to be obtained to cut them; and even in cutting the corner off the landowner has to be applied to. Thus, what with permission for stays, cutting of trees, and cutting off corners, the number of permissions to be obtained is quite as formidable a work as erecting the telegraph; and, indeed, it was at one time so formidable, that an eminent novelist and popular writer, at that time in the Post Office service, was selected to go through a whole district to coax the country gentlemen into giving the necessary permission for erecting the Post Office telegraphs; so that in fact it may be said that Her Majesty's telegraph lines live out in lodgings on sufferance.

No amount of ingenuity or mechanical feeling can make a telegraph line along a crooked country road look either picturesque or mechanical, but very often there is not much mechanical feeling expended on it, and one pole bending one way and another leaning the other, with insulators starting

out of their sockets from strains which they were never intended to bear, make the line a regular misery to those who have any idea of construction in any shape.

As regards underground wires, the railways are not so well adapted for the purpose as the high-road. Neither the side of an embankment or of a cutting is a solid locality to place a line of pipes, as there is likely to be some amount of settling constantly going on, whilst in many places actual slips occur. In some of the cuttings through rock, very little room could be found between the ballasting and the edges of the cutting.

The high-road is not open to these objections. The ground in cross section would be always about level, and the pipes once placed could not slip out of level. The sharp bends, so objectionable to overground lines, would be of little or no importance in underground lines.

The first cost of overground lines is of course much less than that of undergound wires, but if underground lines are laid with care and of the best material, their maintenance should not be great. The rate of signalling on overground wires is undoubtedly greater than on the underground wires, on account of the great electro-static capacity of the latter. But the question is how to relieve the overground system, which is evidently becoming so overburdened that a remedy is required. We believe the proper remedy is to observe the limit at which the electro-static capacity of underground wires interferes with the rapidity in the ordinary instruments used; then to use the overground railway wires for such circuits as are longer than this limit, and to place all the other circuits underground. Of course we do not allude to the wires used by the railway companies for their own purposes, though even railway companies might with advantage to themselves place down two or three wires as a stand-by for their own use, so as not to be left dependent on the frail structures which now and then tumble down over their permanent way.

Nor must it be supposed that we consider the actual system to be employed in underground wires as a matter which is decided. Whether the wires should be pulled into the pipes as at present done by the Post-office following the Electric Telegraph Company, or laid in half pipes as the Magnetic Company did, or whether one system should be adopted on long straight lines, and the other where bends occur very frequently, is a question which requires the consideration of those who are entrusted with the work. Besides trying gutta-percha covered wires, Hooper's corce might also be tried, as its well known low inductive capacity would be an advantage. All these are points for consideration, but certainly Government ought to give some evidence that they see the signs of the times. On all sides the failure of the overground lines is perceived, and something must be done.

In fact, if the lines and rights were now the property of private companies, the chances are that one company would be more enterprising than the others, and, after some of these great interruptions, begin vigorously laying down underground wires, and the other companies would follow. The Government having a monopoly of the public service, there is, of course, less chance of anybody seeing the necessity of a great change, unless, indeed, the inconvenience has been felt by the railway companies more than by the Government or the public.

In Germany the underground system has been begun. In Italy it has been long under consideration, and it behoves our Government not to be behind hand in doing what they can, in spite of the disadvantages under which they suffer through the grumbling that has occurred as to the enormous cost of the telegraphs to the State. The fact seems very clear as regards this cost. If the State only buys an invention long after all risk as an enterprise has passed and it is a commercial success, they must pay a price accordingly. All other Governments had their telegraphs from the moment the fact was proved.

If another winter sees our principal telegraphic communications stopped through snow or wind to the same extent or more than before, the outcry will certainly be greatly increased, and will to a great extent be justified.

ON A METHOD OF DETERMINING THE LOCALITY OF A FRACTURE IN A SUBMARINE CABLE.

By H. R. KEMPE.

In a paper read before the Institution of Civil Engineers on February 23rd, 1858, Mr. F. C. Webb pointed out a possible means of localizing the position of a fracture in a submarine cable by means of a resistance and an electrostatic capacity measurement. Dr. Werner Siemens, in his paper read before the Society of Telegraph Engineers in February last, has dealt with this problem, but he does not completely solve it, or put it in a practical form.

The object of the present investigation is to show how this method may be made useful.

A brief statement of the principle of the test may be advisable.

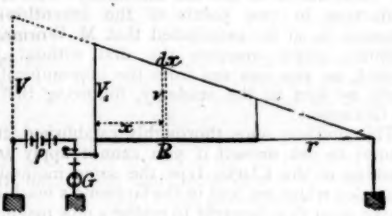
When a cable is broken, the conductor resistance of the portion measured includes the resistance of the fault, and in the ordinary tests it is necessary to eliminate this by a process of depolarization.

Now it is evident that the portion of the cable broken has a certain electrostatic capacity, and if we can determine what this is, we are at once in a position to find the locality of the break. For we know from measurements made when the cable

was perfect what the capacity per unit of conductor resistance is, and the number of these units corresponding to the measured capacity of the broken cable at once gives us what we require.

If the result of a measurement showed that the capacity corresponded to a certain number of units of resistance, and the conductor resistance gave the same result, then it is evident that the fault has no resistance (for the fault can have no capacity), and the conductor resistance, consequently, is the resistance up to the fault.

Now the difficulty is not that of measuring the conductor resistance, but the capacity, for the discharge from the cable takes place at both ends, and the quantity discharged at the nearest end, which is that with which we have to deal, has a proportion to that of the whole quantity in the cable dependent upon the resistance of the cable, the fault, and the galvanometer used to measure the discharge. Also the charge the cable will take depends upon the two first of these quantities, and upon the resistance of the battery used to charge the cable.



In the fig. let ρ, G, R and r represent the resistances of the battery, galvanometer, cable and fault respectively, and let V, V_1, and v represent the potentials of the different parts of the system when the battery is in connection with the cable.

Now when the key is *instantaneously* depressed, so as to put the cable in connection with the galvanometer, the charge in the cable, which is represented by the area included between V_1, and v, flows out at the two ends of the cable in proportions dependent upon the value of the resistances G, R and r.

Let $v\,dx$ be a differential part of the charge. Then the portion of this which will flow through the galvanometer will be—

$$d\,Q = v\,\frac{R + r - x}{G + R + r}\,dx$$

now

$$V_1 : v :: R + r : R + r - x$$

therefore

$$v = V_1\,\frac{R + r - x}{R + r}$$

therefore

$$d\,Q = V_1\,\frac{(R + r - x)^2}{(G + R + r)\,(R + r)}\,dx$$

and the integral of this between the limits $x = R$, and $x = 0$ will give the total quantity (Q_1) flowing through the galvanometer, that is :—

$$Q_1 = \int_0^R V_1\,\frac{(R + r - x)^2}{(G + R + r)\,(R + r)}\,dx =$$

$$\frac{V_1}{(G + R + r)\,(R + r)} \int_0^R (R + r - x)^2\,dx =$$

$$\frac{V_1}{(G + R + r)\,(R + r)}\left((R + r)^2\,R + \frac{R^3}{3} - (R + r)\,R^2\right)$$

$$= \frac{V_1\,R}{3}\,\frac{R^2 + 3\,Rr + 3r^2}{(G + R + r)\,(R + r)} \qquad (A)$$

Now the total quantity (Q) which the broken portion of the cable would take if the end were insulated, and the battery connected to it, would be—

$$Q = V\,R$$

V being the potential of the battery, but—

$$V : V_1 \;:\; :\; \rho + R + r :\; R + r$$

therefore—

$$V = \frac{V_1\,(\rho + R + r)}{R + V}$$

therefore—

$$Q = V_1\,R\,\frac{\rho + R + r}{R + r}$$

therefore—

$$V_1\,R = Q\,\frac{R + r}{\rho + R + r}$$

Substituting this value in equation (A), we get—

$$Q_1 = \frac{Q}{3}\cdot\frac{R^2 + 3\,Rr + 3r^2}{(G + R + r)\,(\rho + R + r)}$$

Now, if f be the capacity per unit of R, then Rf will be the total capacity, and if Q_2 be the charge held by a condenser of F farads capacity charged by the battery C then—

$$Q_2 : Q :: F : Rf$$

Therefore—

$$Q = \frac{Q_2\,Rf}{F}$$

Substituting this value of Q in the last equation, we get—

$$Q_1 = \frac{Q_2\,Rf}{3\,F}\cdot\frac{R^2 + 3\,Rr + 3\,r_2}{(G + R + r)\,(\rho + R + r)}$$

Now $R + r$ is obtained by direct measurement; let it be L, that is—

$$R + r = L;$$

therefore

$$r = L - R.$$

Substituting this value in the last equation, we get—

$$Q_1 = \frac{Q_2\,R_f}{3\,F}\cdot\frac{R^2 + 3\,L^2 - 3\,L\,R}{(G + L)\,(\rho + L)}$$

therefore

$$\frac{Q_1\,3\,F\,(G + L)\,(\rho + L)}{Q_2 f} = R\,(R^2 + 3L^2 - 3\,L\,R)$$

Therefore

$$\frac{Q_1\, 3\, F\, (G+L)\, (\rho+L)}{Q_2 f} - L^3 =$$

$$R^3 + 3\, L^2\, R - 3\, L\, R^2 - L^3 = (R-L)^3.$$

Therefore

$$R = L + \sqrt[3]{\frac{Q_1\, 3\, F\, (G+L)\, (\rho+L)}{Q_2 f} - L^3};$$

Or

$$R = -\sqrt[3]{L^3 - \frac{3\, Q_1\, F}{Q_2 f}\, (G+L)\, (\rho+L)}.$$

Now Q_1 and Q_2 being the discharge quantities from the cable and condenser charged from the same battery, we may substitute the deflections obtained on the galvanometer G in their place. Let them be d and D respectively, then the formula stands—

$$R = L - \sqrt[3]{L^3 - \frac{3\, d\, F}{D f}\, (G+L)\, (\rho+L)}.$$

For example—

Suppose the measured resistance (L) of the cable and fault was 700 ohms:

The capacity per ohm (f) of the conductor resistance = ·03 microfarads.

The resistance (ρ) of the battery = 200 ohms.

The resistance (G) of the galvanometer = 100 ohms.

The discharge deflection (d) obtained from the cable = 1425.

The discharge deflection (D) obtained from a condenser F of 1 microfarad capacity = 300.

$$R = 700 - \sqrt[3]{700^3 - \frac{3 \times 1425 \times 1}{300 \times .03}\, (100+700)(200 \times 700)}$$

$$= 600$$

The great advantage of this method of testing is that the two measurements can be made almost, if not quite, simultaneously. Thus the electrician, taking the resistance test, would, at the very moment he got a steady reading, discharge the cable through the discharge galvanometer, and note the deflection, he is then in a position to localise the fault, as all the other measurements can be made at leisure.

It is of course absolutely necessary that the key be moved from the top to the back contact instantaneously, and to do this a special kind of key would probably be necessary with the two contacts very close together, and with the lever made to move by a gun lock arrangement with a powerful spring.

The above test is one which should be experimented on, as the resistance of the broken ends of a submarine cable may vary between infinity (when the end gets sealed up by the guttapercha being drawn over the end) and nothing (when the copper wire touches the iron sheathing), and this unknown resistance is found by the above method, but it requires experimental proofs.—Ed. *T. J.*

NEW CONTINUOUS CURRENT MAGNETO-ELECTRIC MACHINE.

By ALFRED NIAUDET.

I have explained Gramme's machine to the readers of *La Nature* in the numbers for the 1st November, 1873, and 30th January, 1875. If you refer back to these two articles, and to a pamphlet which I have published on the same subject, you will perceive that the invention of Gramme comprehends two distinct parts.

The first relates to a new method of producing magneto-electric currents, and I have clearly shown in what points this machine differs from that of Pixii or of Clarke. I have stated that there at present exist two classes of magneto-electric machines, those of the type of Pixii, better known by the name of Clarke, and those of the type of Gramme.

The second part of the invention consists in a new method of collecting the currents, or, in other words, in a combination which takes the place of the commutator in the old machines. This chief distinction in two points of the invention of Gramme is so far established that M. Worms, of Romilly, could conceive the first without the second, as you can see from the communication made by him to the academy, following that of M. Gramme.

This division once thoroughly established, it is natural to ask oneself if you cannot apply to a machine of the Clarke type the same method of collection which we find in the Gramme's machine? I have been thus brought to realise a new magneto-electric machine, giving continuous currents. This machine has been thought of by several persons; but I think I am able to say that I was the first to take up the idea, for we have, on the 12th January, 1872, a patent taken out, which every one can read in the report published by the Minister of Commerce.

Three machines were constructed about this time, and we have had occasion to exhibit them before a great number of people.

Description of the Rudimentary Apparatus.

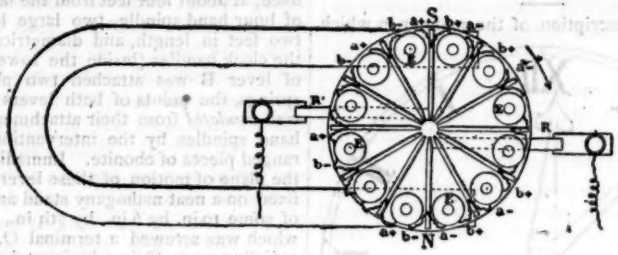
On a circular plate, PP, perpendicularly to its plane, are placed at regular intervals around the axis, AA, a series of straight electro magnets. This system is placed with respect to the poles, N O S, as shown in the figure, and is movable around the axis. The apparatus can be regarded as a Clarke's machine, sextupled, as this machine consists, as a rule, of a magnet and a system of two movable bobbins. The bobbins of the electro magnets are all connected one with the other, the inside end of one being joined to the outside end of the other, exactly the same as a series of galvanic elements would be joined together to form a battery, that is to say, the positive pole of one element to the negative pole of the next.

When the plate turns in the direction of the arrow, this is what takes place in each of the bobbins: In proportion as the distance of the bobbin from the North Pole, N, increases, a current is developed, the positive pole of which is at the outside end, a +, and the negative pole on the inside end, b —, and this current remains the same whilst the bobbin travels from the pole N to the pole S; for the approaching the pole S has the same

effect as the moving from the pole N, and these two effects are similar. But during the second half revolution of the bobbin, it passes from the pole S and approaches N, and, consequently, the nature of the current is the opposite what it was in the first half of the movement; this is what is represented in the figure by the sign a— and b+ at the outside and inside ends of the bobbins. Knowing now what takes place in a single bobbin, let us see what happens in the whole; considering at any moment all the bobbins placed to the right of the line of poles, they are all traversed by currents of a similar nature, which are connected together for intensity, like six elements of an ordinary battery. At the same instant, the bobbins to the left of the line of the poles are traversed by a current of the same nature and equally connected for intensity; therefore, the sum of the currents to the right is manifestly equal to the sum of the currents to the left. Altogether, the twelve bobbins may be compared to two batteries of six elements each, with their similar poles opposed, or if the two extremities of an electric circuit are connected with the points where these two series of elements are opposed, it is at once traversed by the currents of the two batteries, which are then connected up for quantity.

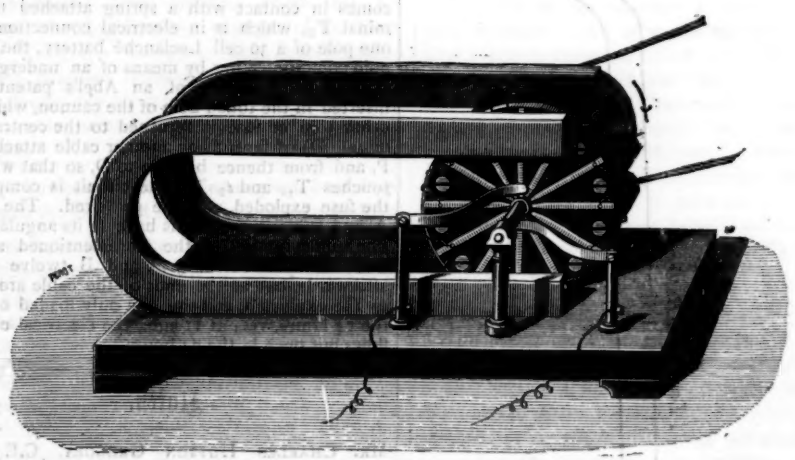
By analogy, to collect the currents developed in the machine which we have described, it is necessary to fix springs which touch the points connecting the several bobbins together, at the instant they pass the line of the poles.

By the same reasons which guided Gramme in the construction of his machine, we have placed pieces of metal radiating from the centre, which communicate with the points of junction of the bobbins, on which the springs R are made to rub in the neighbourhood of the axis, where the currents are collected.



The continuity of the current results from this; that before the springs break contact with one of these radial pieces they are in contact with the next one.

To sum up, you have here an apparatus producing continuous currents analogous to Gramme's machine. If our apparatus, proceeding from the admirable invention of M. Gramme, does not possess much originality, it will, perhaps, have the advantage of explaining more clearly the working, which is difficult enough to understand from the machine used by him as a model.

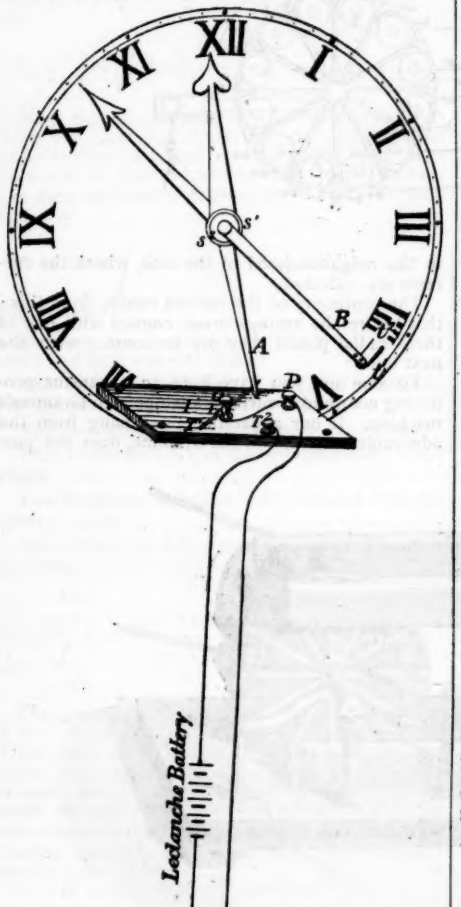


Certain reasons, which it is difficult to explain here, will show that Gramme's machine is superior to ours. It is not impossible, however, that the latter would be employed in cases where a great tension and very little quantity is required. When you wish to establish telegraphic communication

without a battery, as has already been done by machines producing alternative currents, you will find, without doubt, that the extreme facility of making cylindrical bobbins with fine wire justifies the employment of the apparatus which we now, for the first time, present to the public.

MANNER OF FIRING TIME GUN AT PERNAMBUCO.

THE following description of the manner in which



the time gun is fired at Pernambuco has been sent home by Mr. Andrew Jamieson, Assistant Engineer and Electrician on the Western and Brazilian Line.

In the above sketch the large circle is to indicate the dial face of the large clock fixed in the tower of the Arsenal de Marinha, Pernambuco, which, you may remember, is some 400 yards from the S. and B. Telegraph Office. S is the hollow spindle of the hour hand, S_2 the spindle for the minute hand. To these spindles I firmly fixed, at about four feet from the face, or inside end of hour hand spindle, two large levers, A and B, two feet in length, and diametrically opposite to the clock handles (inside the tower). To the end of lever B was attached two platinum pointed springs, the points of both levers A and B being well *insulated* from their attachment to the minute hand spindles by the intervention of suitably arranged pieces of ebonite. Immediately underneath the plane of motion of these levers (A and B) was fixed on a neat mahogany stand an ebonite slab (I) of some 10 in. by 6 in. by $\frac{3}{4}$th in., at the centre of which was screwed a terminal O, with a lever L radiating upon O in a horizontal plane, but unless acted upon was kept in an angular position, by a light spring, across the length of the ebonite slab. This spring and lever L were so adjusted that when the hour hand came to ten minutes to twelve noon, the end of lever A fixed to same spindle (as the time drew nearer and nearer to twelve) made contact and gradually brought L to a position at right angles to the length of the ebonite slab, whereby the other end T_1 of L, was now in a position to make contact with the more quickly passing lever B at its platinum point t_1, and at the same moment (the sixth stroke of the clock) spring t_2 comes in contact with a spring attached to terminal T_2, which is in electrical connection with one pole of a 30 cell Leclanché battery, the other pole communicating by means of an underground cable, with one side of an Abel's patent fuse inserted in the touch-hole of the cannon, while the other side of fuse is returned to the central terminal (O) of lever L by another cable attached to P, and from thence by wire to O, so that when t_1 touches T_1, and t_2 T_2, the circuit is completed, the fuse exploded, and the gun fired. The levers A and B move on, L falls back to its angular position under action of the aforementioned spring, and is only affected by A and B twelve hours afterwards, but as the ends of the cable are freed by the explosion, and the gun only loaded once in the 24 hours, viz., at 11 a.m., the electrical current flows but once in the 24 hours.

Notes.

MR. CHARLES HUTTON GREGORY, C.E., past President of the Institution of Civil Engineers, and consulting engineer for various works in the colonies, has been made a Companion of the Order of St. Michael and St. George. When Mr. Gregory filled the presidential chair at the Institution of Civil Engineers, it was noticed by many that he made one of the best chairmen that had ever presided, keeping the whole meeting in regular parliamentary order as well as the most practised Speaker of the House of Commons could have

done. His kind and sympathetic manner to the younger members of the profession have made him many friends, and we heartily congratulate him on this new recognition of his talent and ability.

We regret having to announce the death, on the 15th March, of Mr. Seymour Clarke, who was for many years traffic manager on the Great Western line, and afterwards for many years general manager of the Great Northern. When the telegraph was first erected on the Great Northern in 1852, Mr. Clarke showed by the interest he took in the organization of the rules and other matters for the employment of the wires that he fully appreciated their importance. In 1866 Mr. Clarke interested himself in a project for a telegraph from Rangoon through Siam to Singapore, from Malacca through Sumatra to Java and the Dutch Islands to the shores of Australia, with a branch from Savoy through Bankok to Saigon, and thence, with the approval of the French Government, through Cochin China to China Proper. Mr. Clarke was a man of great ability and energy, and was much respected by a large circle of professional acquaintances and employés.

A paper on the Clamond Thermo-Electric Pile is in preparation by Mr. L. Clark for reading at the Society of Telegraph Engineers.

The *Buenos Ayres Standard* states that Mr. Oldham, the Engineer and manager of the River Plate Telegraph Company, and superintendent for the Brazilian Submarine at Montevideo, reports favourably so far on the work of laying an extra cable between Buenos Ayres and Banda Oriental.

Cape advices state that the telegraph from Cape Town to the Diamond Fields had been completed.

Steps have been taken to lay down immediately a subterraneous line between Halle and Berlin, and in future all German Telegraphs will be underground.—*Engineering.*

In December last, a cable was laid by the Telegraph Construction Company, between Kingscote, Kangaroo Island, and Tankatilla, South Australia, for the South Australian Government. The cable is 38 nautical miles in length; main cable 10, No. 6, weighing 3·89 tons to the mile; shore-end at Kingscote, 8 tons per mile, 7 nautical miles; and at Tankatilla, 12 tons per mile, 3 nautical miles. The cable was laid from the s.s. *Edinburgh.* Mr. Laws acted on the part of the contractors, and Mr. R. E. Peake on the part of Clark, Forde & Co., Engineers for the South Australian Government. Mr. Todd, General Superintendent of Telegraphs for the South Australian Government, was also officially present.

The Telegraph Construction Company have commenced the manufacture of the cable for duplicating the Eastern Company's system between Suez and Bombay.

A Committee appointed by the Admiralty, the Board of Trade, and Trinity House, to consider the regulations for preventing collisions at sea, have issued their report. Article 5 provides signals for ships laying telegraph cables, or otherwise not under command.

During the late storms the Great Western line appears to have suffered the most from the destruction of the telegraph. About 159 poles were thrown down between Paddington and Reading. The block system was suspended and the old time system adopted. At one time messages could only be sent from London to Southall, they then had to be conveyed to Slough, whence they were transmitted to Bristol. Mr. Spagnoletti has been actively employed on the re-erection of the line. In addition to the ordinary staff some sappers were employed.

An inquest has been held on the body of William Stevens, killed by a telegraph wire at Islington. It appears that the wire broke before the accident, and that a gentleman, with the best intentions, made fast the end to some railings, but left it hanging across the omnibus yard, and that the poor deceased drove at a trot against the wire. The evidence given on behalf of the post office is stated to be to the effect that "the wire in question would have been taken down next year because of its being worn out. It would have lasted till then but for the violence of the storm." This does not seem very satisfactory. If all the other wires over head are run to within a year's estimate of their life, every heavy gale must bring some down, even if their life can be estimated to a year by the most competent judges.

A correspondent writing to *The Times*, says: "With reference to your remarks in *The Times* of Thursday on aërial telegraph service, allow me to remind you of a former fatal accident on Blackfriars-bridge some years ago. An omnibus had reached the crown of the bridge one gusty morning, when the telegraph wire, breaking, caught a passenger round the neck and dragged him from its top to the ground in an instant, causing his death. The similarity of these accidents is notable."

Mr. Herring has issued a pamphlet entitled "Vis Inertia at the Post Office: Mr. Herring and the Telegraph Department. Present Position of the Question. February, 1876. Fourth edition. Longmans." It contains favourable reports by

Messrs. Clark and Forde on Mr. Herring's instrument, addressed to Mr. Herring, and reports from Sir William Thomson and Professor Fleeming Jenkin to Mr. Scudamore, besides a great deal of correspondence. We cannot at present enter into the merits of the case.

The Directors of the Direct United States Cable Company have reprinted in pamphlet form the report of Sir William Thomson and Mr. F. Bramwell on the breakages in the Direct Cable, together with Sir William Thomson's report on the electrical state of the cable, dated September 23rd, 1875, and a report by Mr. Fife Jamieson of tests taken 8th, 9th, and 10th of February, 1876. This last report is not dated. By it, however, we gather that the cable is 2422·5 N. miles in length, and has an insulation resistance per N. mile at the natural temperature of 5,475 millions of Siemens' units at the end of the first minute, and a copper resistance of 3·0193 Siemens' units per N. mile. (Why cannot Mr. Siemens conform to English systems, at least in England, and adopt the B. A. unit?) However, reduced to B. A. units this is 5,201, as against 2,945, that given for the 1865 Atlantic Cable in Clark and Sabine, and 5,200 for the French Atlantic by the same authority. This speaks well for the insulation of the Direct Cable, although, as the diameter of the conductor and insulator are not given, it is not possible to reduce the insulation of the Direct Cable to that of a cable of the same diameters as the French Atlantic. In other words, it is not possible, without further data, to compare strictly the specific resistance of the guttapercha insulating medium as manufactured in the one case by the Telegraph Construction Company in 1864 and 1868, with that manufactured by Messrs. Siemens Brothers in 1873. The insulation after submersion of the 1873 and 1874 cables laid by the Telegraph Construction Company has never, as far as we know, been made public, so that the latest comparison must be with the French Atlantic.

At various times attempts have been made to use electricity as the means of producing from the consumption of zinc a motive power. It does not appear that the failure of previous attempts has entirely damped the ardour of inventors. At present we have electro-motor machines by two separate inventors on view in London. The Comacho magnetic machine, with its concentric iron tubular magnets, may be seen at the offices of Messrs. Ulrich, Plambeck, and Darkin, 171, Queen Victoria Street. The idea of placing iron tubes and layers of wire alternately seems now to be striking everybody very forcibly as a good idea. Mr. Faulkner exhibited the effect of placing an iron tube outside a magnet very graphically at Mr. L. Clark's *conversazione;* and, in 1874, a man (whose name we forget) was going about London with a compound magnet with two or three cylinders. Mr. Camacho's English patent however dates from October, 1873. There can be no doubt of the advantages of this form of magnet; but experiments on the resistance of the circuit, weight lifted, electromotive force, and consumption of zinc, &c., would form an interesting subject. The machine with five cells of a bichromate battery works three or four sewing-machines. Attempts to work it with the thermo-pile have hitherto failed. This is very likely, because the elements of the thermo-pile are coupled up in considerable series, so that, considering the resistance of each element, the whole resistance must be great compared with the resistances of the wire round the magnets. A thermo-pile should be made of low resistance by coupling a number of elements together in parallel circuit, and then taking some ten or twelve, or more, of such series coupled in succession. It is no doubt worth considerable experiment to attain a successful result from the thermo-pile, as in that case, by merely turning on the gas, a lathe or sewing-machine may be made to work.

Another electro-motor machine, patented by Mr. Nelson, is to be seen driving a small pump at the offices of Mr. Applegarth, Palmerston Buildings. It appears to do considerable work with 8 Bunsen elements, coupled in four pairs, so as to give a resistance of 2 elements and electromotive force of 4. A larger machine is in construction by Mr. Henley, under the superintendence of Mr. Ormiston, for Mr. Applegarth, and we hope soon to give some account of its performance. It appears a very promising machine.

Messrs. Chas. H. Davis and Frank B. Rae, of New York, have issued a prospectus of a work entitled *Hand Book of Electrical Diagrams and Connections*, which they propose to issue by subscription. It will be six by nine inches, and will contain about 32 plates, which will be photo-lithographed by the *Graphic* Company of this city, handsomely bound, and a work which every telegrapher will desire to possess. The designs are artistic, and will comprise full and complete diagrams of all Morse instruments in use in this country, including duplex, quadruplex, and automatic apparatus used in working ocean cables, etc. A large number of subscriptions have already been secured, and no doubt is entertained that there will be a general demand for the work, which is unique in conception and design. The subscription price has been fixed at the low price of 1·50 dols, which is only warranted by the certainty of

a large demand for and sale of the book. Subscriptions may be sent to Mr. C. H. Davis, or Frank B. Rae, at the Western Union office in this city.—*Telegrapher.*

At the dinner of the members of the Institution of Civil Engineers Lord Carnarvon made the following remarks:—And as with railways so with telegraphs. Some 20,000 miles are open in the great continent of Australia. The whole of the eastern side is now surrounded by an electric wire; the great Colonies of New South Wales, Victoria, Queensland, and South Australia, and within the last few days New Zealand itself, have all been brought into confraternity with one another, and I will venture to say into closer relationship with the Mother Country (Applause). These are great triumphs to have accomplished; and if our colonial empire be, as I believe it will be, perhaps the greatest monument which will be left of English power, of English creativeness, of English practical genius; this, too, will be equally remembered, in times to come, that in the praise and the credit and the honour of that great work, the civil engineers of England are entitled to bear at least their full share (Loud applause).

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

The discussion upon Dr. Werner Siemens' paper, "Contributions to the theory of Submerging and Testing Submarine Telegraphs," a *résumé* of which has already appeared in the *Journal*, was commenced at the meeting of the Society held on the 9th of February, Mr. C. V. Walker, F.R.S., the President, in the chair.

Mr. Walker having alluded to the fact that the paper could be appreciated only after careful reading, referred to the first cable which was laid across the British Channel. This was manufactured for Mr. Reid the elder, and at the time grave doubts were entertained as to the undertaking: in fact he (Mr. Walker) has in his possession a letter from Mr. John Lewis Ricardo, the then chairman of the Electric and International Telegraph Company, asking if there really was any truth in the report that an attempt was about to be made to lay a cable across the channel.

Mr. Willoughby Smith (rising at the President's invitation) questioned the accuracy of Dr. Siemens' opening statement, "The starting point of submarine telegraphy is to be found in the subterranean lines constructed in Prussia during the years 1847 and 1852." Prior to 1850 there is difficulty in obtaining reliable data on account of the imperfect condition of the English and continental subterranean lines; the successful laying of the line from Dover to Calais in 1850 gave the first genuine impulse to submarine telegraphy. Dr. Siemens' statement, "In the year 1846 the author suggested to the Prussian Government the use of guttapercha as an insulating material, this gum having then recently become known in Europe," and the further assertion that "in 1847 the author and Mr. Halske constructed a covering machine, by means of which the guttapercha, rendered plastic by heat, is pressed round the wire without any seaming," were next examined. It is allowed that in 1843 the first samples of guttapercha were sent to the Society of Arts by Dr. Montgomerie, and in the following year several articles roughly made from it were exhibited. In May of the latter year the first patent with guttapercha named in it was taken out, while in the two following years various patents were obtained in connection with it. It was in 1848 that Faraday published the results of his researches into the electrical qualities of guttapercha, and if, as stated, Dr. Siemens had drawn the attention of the Prussian Government to it two years before, it appears strange that so careful a man as Faraday should have brought his discoveries forward as something entirely new. In 1848 Mr. Charles Hancock brought out the first patent in which guttapercha and electricity are mentioned together, while towards the close of the following year the Guttapercha Company began to supply the Prussian Government with large quantities of "sulphuretted guttapercha" covered wires. The insulation of these wires speedily deteriorated, on account of the large quantity of sulphur which was mixed with the guttapercha. It was in the same year that the Guttapercha Company commenced the manufacture of the line which in the following year, 1850, was successfully laid between Dover and Calais; and in 1850 Ernest Werner Siemens patented a machine for covering wire with guttapercha—a machine which was inferior to that already used by the Guttapercha Company. The wire laid by Mr. Reid from Dover to Calais soon failed, probably from the fact that the shore ends consisted of a copper wire covered with cotton, and, after being passed through a solution of indiarubber, enclosed in a leaden tube. These were put down several days before the guttapercha wire, which tested very well, was joined on to them. The Mediterranean cable was successfully laid in 1854, between Corsica and Sardinia, and had Mr. Brett used a steamer in place of a sailing vessel, he would probably have been as fortunate in completing the Sardinia to Africa section. As it was, he had no control over the ship, and so lost the cable; it was a very heavy cable, and far exceeded in weight the light cable laid by Mr. Newall in 1857 over the same ground.

Mr. C. F. Varley commenced by disputing the claims put forward in Dr. Siemens' paper as to the first submarine lines, and pointed to the germ of the idea having sprung into existence very early in the present century. He then proceeded to a minute investigation of the forces brought to bear on a falling cable, and pointed out that a cable, after passing over the sheave, consisted of a number of minute hempen threads standing out at right angles to the body of the cable. The friction between these and the water was too important to be lost sight of, and must considerably modify the mathematical results arrived at without taking that into account. The introduction of water tanks on board the cable vessels and the regulation of the

break power, to allow of the necessary amount of slack being paid out, were next dealt with. Mr. Varley likewise fully explained the loop-test, and claimed it as his own discovery, as well as his method of localising the faults in a cable by testing from one end only.

The discussion was continued at the meeting held on the 23rd of February. Mr. C. V. Walker, F.R.S., in the chair.

Mr. Walker corrected an error made in the matter of dates by Mr. Willoughby Smith at the previous meeting. The first three patents taken out for telegraph wires covered with guttapercha were—Mr. W. H. Barlow and Mr. Thomas Forster, on April 27th, 1848. On the following day, April 28th, he (Mr. Walker) sent two miles of wire to Mr. Forster to be covered with guttapercha. The plan then adopted was to pass two strips of guttapercha between grooved rollers heated by steam—there being eight or ten wires between the strips. The bands of guttapercha were then pressed around the wires, which were kept apart during the process. The second patent was by Mr. John Lewis Ricardo, and dated 4th September, 1848; while the third, dated 23rd April, 1850, was by Mr. Siemens.

Mr. Varley then concluded his observations, claiming for English enterprise the progress of submarine telegraphs, and for English pluck and perseverance our possession of any cables at all.

Dr. C. W. Siemens, speaking at some length, defended his brother from several of the charges brought against the statements at the commencement of his paper. Referring more particularly to the introduction of guttapercha for electrical purposes, he stated that his brother received the first piece of guttapercha from himself, and that the investigations which were carried out were undoubtedly prior to the date of Faraday's researches.

Mr. Thomas Forster (rising at the President's invitation) proceeded to explain the method originally adopted in the first patent for covering wires with guttapercha, and the reasons why this did not succeed effectively. The guttapercha was first of all cleansed by putting it through a cylinder and washing; it was then masticated between two hot rollers, and again passed between two pairs of rollers, one above the other, with guides at the sides. From these it issued in strips, each about four inches wide. These strips were next taken to a pair of fluted rollers, constructed to carry twelve wires through the flutes. One strip of guttapercha being placed over and the other under the wires, the band of guttapercha and the wire came out at the further end as a complete belt, with the edges of the flutes nearly cut through. This method could not, however, be pronounced a success, for, owing to the large amount of woody material with which guttapercha is charged, this could not be got rid of entirely, and numerous faults would consequently make their appearance in the wires when first tested. Wires of this description were, however, laid and used with advantage. Those through the whole of the tunnels on the South Eastern Railway were manufactured in this way. A great improvement was very shortly afterwards effected in the process of covering the wires by the Guttapercha Company. The cylinder employed had a small box at the side, and was kept heated by a steam jacket; the guttapercha was forced down by a piston, and at the extreme end was a small box with a trough of water. Each time the wires passed through, a thin coating of guttapercha was placed on them, and as several coatings were in all fixed before the operation was completed, the faults in one coating were covered over by one or other of those put on afterwards. Prior to this the chairman of the Electric and International Company had patented a mode of keeping the wires in one band of guttapercha, instead of covering them separately; but the plan did not answer, owing to the difficulty which was experienced in making a perfect union of the two strips of guttapercha.

(To be Continued.)

THE INSTITUTION OF CIVIL ENGINEERS.

At the seventeenth ordinary meeting of the session, held on Tuesday evening, the 21st of March, Mr. Geo. Robert Stephenson, president, in the chair, the paper read was descriptive of "The Hydraulic Canal Lift at Anderton, on the River Weaver," by Mr. Sidengham Duer, B.Sc., Assoc. Inst. C.E. This is one of the most novel engineering works. Barges, floating in a chamber or trough, are lifted up 50 ft. 4 in. by a single hydraulic press. There are many ingenious arrangements, and the whole work does great credit to Mr. Duer, the engineer, and to Mr. Emmerson, the contractor.

ROYAL INSTITUTION.

On the Action of Light on Selenium.

Dr. Siemens gave a lecture on this subject before the Members of the Royal Institution, on the 18th February last.

He commenced by reference to both the transient and permanent effects of light, to its action as a moving force and as a chemical motor, and closed his introduction by a statement of the hypothesis that it is not heat but the ray of light that breaks up carbonic acid in the leaves of plants, thus separating the carbon. Thereafter followed a description of selenium, considered from a chemical and physical point of view.

The first observation of the effect of light on crystalline selenium, viz., its increasing the conductivity, was made by Mr. May, a telegraph clerk at Valentia, and was communicated to the Society of Telegraph Engineers on the 12th February, 1873, by Mr. Willoughby Smith, a member of that body; this observation was confirmed by subsequent experiments. Within the last year, Professor Adams, of King's College, and Dr. Werner Siemens, of Berlin, have made independent inquiries: those of the latter formed the principal subject of the address.

The experiments on selenium were made through the assistance of a sensitive element, composed of two spirals of platinum wire, running parallel without touching, placed between two thin plates of mica, the interstices between the coils and mica being filled with molten selenium. The two ends of the coil protruded and served to insert the element in a galvanic circuit. The experiments showed that amorphous selenium did not conduct electricity either in light or darkness;

that selenium formed by heating to 100° C for some time and then cooling, showed an appreciable conductivity in light, but a very slight one in the dark. This selenium has been called modification No. 1, or electrolytic; modification No. 2 being metallic, is formed by heating to about 210° C, and keeping several hours at this temperature before cooling. Its conducting power is very much greater than that of the other modification.

The effect of temperature was also the subject of experiment.

An amorphous preparation of selenium is placed in a galvanic circuit and heated in an air bath, kept constantly at a temperature of 260° C.: it is found that up to 80° C no current passes; that from this temperature to that of 210° C, the conductivity rapidly increases, whilst it again diminishes up to 240° C, at which point it reaches a minimum; on cooling, the conductivity varies in the same manner, but in a different ratio. On comparing the effects which are actually produced in heating the selenium, with what would take place if the selenium simply increased in temperature, it is found that there is a spontaneous liberation of heat between 80° C and 210° C, whilst there is an absorption during melting.

From a consideration of these experimental results, Dr. Werner Siemens has extended Helmholz's theory that the conductivity of metals varies inversely as their temperature from the absolute zero, in substituting the expression total heat for temperature, and considers the specific heat of selenium to be an extremely variable quantity. His explanation of the action of light in selenium is that there is a change of its molecular condition from the first, or electrolytic into the second, or metallic modification, or that, in other words, there is a liberation of specific heat upon the illuminated surface of the crystalline selenium, which liberated heat is reabsorbed when the liberating cause has ceased to act. This hypothesis is favoured by the circumstance that time is necessary for the complete dispersion of the effects of light, and that the effect of light is greatly diminished by long exposure, causing a readjustment of the specific heat through the mass, the galvanometer needle tending to return towards its zero position; this fatigue of the sensitive plate wears off by hours of rest, but days are required to restore the previous degree of sensitiveness.

The effect of the different rays of the spectrum upon the sensitive plate was also shown, the actinic and dark heat rays having no appreciable influence upon it.

Dr. Werner Siemens' selenium photometer was exhibited, which consists of a selenium plate not affected by the changes to which the substance is liable, mounted upon a vertical axis, upon which it can be turned through a certain angular distance limited by stops. By this instrument the intensity of light can be measured in a manner which is absolute for white light.

The lecture concluded with some experiments on a selenium eye, which Dr. C. William Siemens had constructed, to illustrate the sensitiveness of the selenium preparations. It consisted of a hollow ball with two openings opposite each other, the one being furnished with a lens of 1½ inches in diameter, and protected with slides, representing eyelids, and the other having an adjustable stopper, carrying a sensitive plate connected up to a galvanometer and one Daniell's element.

On placing an illuminated white screen before the eye, there was a very considerable deflection of the galvanometer needle, a red screen produced a smaller deflection, a blue a still smaller, and a black hardly any appreciable motion. The eye was also extremely sensitive to the different light rays of the spectrum, but was unaffected by the heat rays. As explained, it would not be difficult to make the eyelids close automatically under the influence of a very bright light, by arranging a contact and electromagnet in connection with the galvanometer; thus imitating the automatic action produced by light on the natural eye.

PHYSICAL SOCIETY.—11TH MARCH.

THE President, Professor G. C. Foster, F.R.S., in the chair.

The following candidates were elected members of the Society:—W. H. Coffin, T. D. Humpidge, and Rev. G. H. Hopkins.

Professor W. G. Adams gave an account of some researches on which he has been engaged in connection with the influence of light and heat on the electric conductivity of selenium, and exhibited numerous experiments in illustration. The subject has also been studied by Lieut. Sale, and Dr. W. Siemens of Berlin, and, as a general result, it is found that, after it has been kept in the dark, the resistance of the metal is diminished by exposure to light. The effect, however, both of heat and light is different in the several states through which the metal passes. Thus, when a piece of amorphous selenium is gradually heated to about 100° C, kept at this temperature, and slowly cooled, its resistance at first is so great that it cannot be measured by the ordinary arrangement, but as its temperature increases the resistance diminishes, and increases again more slowly when the metal is allowed to cool. The resistance of several pieces, which at the highest temperature were from 1 to 3 megohms, were found to be from 100 to 130 at the ordinary temperature. If this selenium be placed in a paraffin bath and heated, its resistance diminishes, and when the temperature is kept constant above 140° for some hours, and the metal is then slowly cooled, it assumes a crystalline structure, and its resistance *diminishes* as it cools. The resistance of such selenium at ordinary temperatures *increases* with the temperature. The effect is more marked as the temperature of the paraffin bath is increased. In studying the effect of light the metal, which had been heated to 140° C, was exposed to a candle at distances of 1, ½, and ¼ metre. The initial resistance being 115,500 ohms, the readings in these three cases were 112,000, 108,700, and 101,500. Deducting each from the initial number, we have 3,500, 6,800, and 14,000 ohms as the changes of resistance due to exposure at these distances. Hence the effect of light varies inversely as the distance, or, what amounts to the same thing, directly as the square root of the illuminating power. These considerations have led Professor Adams to suggest the use of selenium for comparing the illuminating powers of different sources of light, and he exhibited the arrangement which he proposes to use for this purpose. The action of

light of different degrees of refrangibility was then exhibited by allowing the light from several parts of a spectrum of the electric lamp produced by a bisulphide of carbon prism to fall on the metal, the remainder being cut off by means of a screen in which there was a narrow slit. The violet light gave a deflection of about two divisions on the screen, the greenish-yellow four, the orange-red five-and-a-half, and the deep red nine divisions. The effects produced by the greenish-yellow and the deep red are at times nearly equal. It may easily be shown by raising the temperature of the metal that the effect of light on its conductivity is essentially the same in kind at a low and moderately high temperature. The fact that light and not dark heat produces the observed effect has been shown by sending the beam through solutions of iodine in bisulphide of carbon. A very small effect on the metal was always observed, but this may be assumed to have been due to light, as in all cases it was possible to see the form of the carbon points through the solution. This fact may also be strikingly shown by exposing selenium, through which a current is passing, to the flame of a Bunsen burner—first when in its ordinary condition, and afterwards with the air openings at the base closed. It was shown that whereas in the first case the effect produced was equivalent to three divisions of the scale, in the latter case one-tenth of the current produced by the exposure deflects the needle to the end of the scale.

Professor Stoney pointed out that the action of light on selenium increases with the amount of heat accompanying that light. He suggested that the photographic effect of selenium might have some relation to the action under consideration.

Professor Barrett thought that a solution of iodine in bichloride of carbon might give more satisfactory results, for this liquid is more opaque than a solution in the bisulphide.

Professor Guthrie inquired whether the action on the metal is superficial or extends into the mass. If a definite answer could be given to this question it seems likely that we might determine whether electricity flows on the surface of a conductor, or is uniformly distributed throughout the mass. For if we have an *opaque* substance, the conductivity of which is influenced by light, it would suggest that the former is the case. The question, however, would be very difficult of solution, but perhaps the variations in resistance in two bars of selenium which only differ in diameter, might throw some light on the subject.

Professor Adams, in replying to the various questions, mentioned that he has examined the effect of light deprived of the ultra-chemical rays, but the change seemed to have no effect. He has also made experiments on the influence of light after passing through glasses of different colours, but there is considerable difficulty in ascertaining how much of the effect is due to the degree of refrangibility, and how much to the change in the intensity of the light. The effect is most intense in the greenish-yellow and the deep red, and it is worthy of remark that at these two points groups of bands are observed in the spectrum of the metal. He compared the effects observed with phosphorescent effects, in which case there is certainly some superficial action. The conductivity *may* be improved by some alteration of the surface, but Professor Adams has suggested that light may modify the molecular condition of the metal so as to call into play something of the nature of electromotive force. He showed an experiment which proved that if the resistance of a bar of selenium is measured with a given current passing along it in one direction, then, when this current is reversed, the resistance is entirely different. This seems to bear some analogy to electrical polarization, only the action is in an opposite direction, for it appears to be such as to help the current rather than oppose it.

(To be Continued.)

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday, the 15th inst., at the Institution of Civil Engineers; Mr. H. S. Eaton, M.A., President, in the chair.

R. Trout Hawley Bartley, M.D.; John Wuford Budd; Lieut.-Col. George E. Bulger; W. Brown Clegram, M. Inst. C.E.; J. Sanford Dejason; John Eunson, Assoc. Inst. C.E.; Thomas W. Grindle, Assoc. Inst. C.E.; Major F. Bonnycastle Gritton; Junius Hardwick, F.R.C.S.; Alfred O. Walker; and Rev. E. William Watts, M.A., were balloted for, and duly elected Fellows of the Society. The names of eighteen candidates for admission into the Society were announced.

The following papers were then read :—"On the Rhé-Electromètre of Marianani," by Robert James Mann, M.D., F.R.S.; "On the Variation of Errors in Hydrometers," by R. Strachan, F.M.S.; "On the Deduction of Mean Results from Meteorological Observations," by Sir F. Kämtz, translated from the "Repertorium für Meteorologie," by J. S. Harding, F.M.S.; "Summary of Observations made at Stanley, Falkland Islands, during 1875," by F. E. Cobb; "Contributions to the Meteorology of West Australia," by R. H. Scott, M.A., F.M.S.

The Rhé-Electromètre, a small apparatus, constructed by Mons. de Vos of the Rue Croisades, Brussels, but suggested and named by Professor Melsens, of the Government School of Veterinary Medicine at Brussels, was exhibited by Dr. Mann, the Ex-President of the Society. The instrument is termed Marianani's Rhé-Electromètre, and is intended for the investigation of electrical discharges between the atmosphere and earth. It consists essentially of a coil of copper wire turned round a pasteboard tube, and carrying a traversing magnetic needle mounted upon a vertical pivot immediately above the coil. The apparatus is so placed that the magnetic needle is ranged north and south by the earth's magnetism, and that the coil then crosses its axial line at right angles. A small iron bar is inserted as a core within the axis of the coil. Whenever a spark of electrical discharge of high tension passes through the coil, the internal iron bar becomes a magnet, and deflects the magnetic needle traversing above—the deflection of its north point being to the east or to the west, accordingly as the spark passes in one or the other direction through the coil. When the iron bar has been thus magnetized by a spark, it has to be deprived of its magnetism by heating before the instrument is used with it again for a fresh observation. But a fresh

number of neutral bars are kept always on hand to be employed in succession.

This instrument is very sensitive. A very slight spark from an artificial electrical machine, or even from an electrophorus, suffices to give magnetism to the core, and to cause deflection on the traversing magnet. Its cost does not exceed ten francs, and Professor Melsens is very sanguine that it will prove a useful instrument for an extended investigation of the changes and intensities of atmospheric electricity. The instrument is now used in the telegraphic offices of the Belgian lines, and formal official returns are made of the discharges which are indicated by it. The coil is placed in continuation with the earth wires, which are provided for the protection of the instruments in the telegraph offices. Prof. Melsens states that the magnetic needles in the offices furnished with the apparatus are deflected briskly by a lightning discharge, and that they are not unfrequently recalled to zero, either briskly or gradually, by a subsequent discharge. Occasionally the deflection is reversed by the second discharge. Mons. Melsens finds that ordinary commercial iron wire serves generally for the construction of the iron bars for the core. He has more difficulty in procuring iron that can be satisfactorily rendered neutral by heat than in finding iron that gives ready indications of the disturbance. He desires very much that this simple and uncostly instrument should have an extended trial amongst telegraphists as a convenient means for investigating the movement, conditions, and rate of progress of atmospheric disturbances. The instrument which was shown at the Meteorological Society will be included in the Loan Exhibition of Scientific Instruments about to be opened shortly at South Kensington.

VICTORIA (PHILOSOPHICAL) INSTITUTE.

THE usual fortnightly meeting of this Society took place on Monday at 10, Adelphi-terrace, when a paper was read upon the Flint Implements found in Brixham Cavern, in which the author, Mr. Whitley, alluded to the statements of Mr. Pengelly, whose active superintendence of the exploration of the cavern under the auspices of the Royal and Geological Societies was deserving of the warmest thanks of all geologists. Mr. Whitley complained that the Report of the Royal Society and the specimens had been allowed to lie by for fifteen years before being published and rendered accessible to the public. The consequence was, that for a long time theories having no foundation in fact had been promulgated as to these specimens, and several statements in regard to Brixham Cavern and its contents had been made in well-known geological works, which did not accord either with the recent Report of the Royal Society or Mr. Pengelly's subsequent one.

Amongst those to whom special invitations to the meeting were sent were the Duke of Argyll, Mr. Pengelly, Mr. Ramsay, and Mr. Milne.

The lecture, which was illustrated by drawings and photographs of the specimens found by Mr. Pengelly, was followed by an interesting discussion, in which Professor Tennant, F.G.S., Mr. T. K. Callard, F.G.S., Mr. Pattison, F.G.S., Mr. Galloway, F.G.S., Captain Petrie, F.G.S., Admiral Fishbourne, C.B., and others took part.

EXETER LITERARY SOCIETY.

THE members of this society were treated to a lecture of a scientific nature at the upper room of Victoria Hall on Thursday evening. The subject was "The Telegraph, its History and Application," by E. T. Rolls, Esq., A.S.T.E., of Lympstone, and it was treated in a very interesting as well as instructive manner. Mr. W. Mortimer presided. The lecturer said the word telegraph was derived from two Greek words signifying to write at a distance. He then explained, aided by diagrams, the various modes of communication by signalling by the ancients. Reference was next made to the hydraulic telegraph, the pneumatic telegraph, electricity, and the combinations necessary to produce it, and the laws which governed it. The first practical application of electricity to telegraphy was, he said, by Cooke and Wheatstone in 1837. He then explained how the electric current worked the needle of the instrument, and how the needle indicated the letters, illustrating his remarks by a number of experiments upon a large dial placed in front of the platform, and worked from a smaller instrument at the further end of the stage. Wires in communication with the office at the South Western Railway Station at Waterloo were brought into the room and attached to a small instrument, and communications were exchanged. A fresh wire was attached to the instrument and a message sent to Barnstaple, but no answer was received, owing, probably, as it was explained, to the office being closed there. A few words in reference to the improvements made lately in the instruments were added.

The lecturer also described the block system upon railways, pointed out its incomparable advantages over the old time system, and practically illustrated its working with the assistance of three sets of Mr. W. H. Preece's instruments, which were imagined to be at three neighbouring stations.

The lecturer further stated that the efficacy of this system was abundantly proved by the fact that upon a large and busy line like the London and South Western, where its use was universal, collisions were absolutely unknown, a statement received with applause.

The relation of some very amusing blunders that had been made in telegraphing, &c., concluded the lecture. The usual votes of thanks were afterwards passed.—*Exeter Flying Post.*

Telegraph Companies.

MEDITERRANEAN EXTENSION TELEGRAPH.

THE ordinary general meeting was held on February 29, at the London Tavern, Bishopsgate Street; Mr. Henry Moor in the chair.

The directors, in their report for the half-year ended 31st December, recommended payment of the usual half-yearly dividend on the eight per cent. preference stock, and of a dividend at the rate of 3 per cent. per annum on the ordinary share capital of the company.

The Chairman moved the adoption of the report.

The Hon. A. Ponsonby seconded the motion.

Mr. G. Packer said that all telegraphic companies appeared to be under a cloud, and this one under the darkest. If they excluded the Government subsidy, the amount earned was only £2,471, while the expenses were £1,930, making the expenses about 80 per cent., as against 20 per cent. of most other telegraphic companies. When the subsidy expired, at the end of six years, he feared the position of the company would be bad indeed, and that the share capital would be almost extinguished. He should like to know whether it was supposed the Government would renew the subsidy at the end of the term.

Sir J. Carmichael said the directors would be glad if, by negotiation with the Treasury, there could either be a renewal of the subvention or the payment of a lump sum, and there would be no harm in making an effort in that direction. It was possible that at the end of six years the Government might wish to continue the subvention. Certainly, the loss of traffic by this company was entirely to be ascribed to the permission granted to the other company to lay the line from Marseilles to Malta. He thought they had a strong claim on the Government, whose decision, however, he could not venture to anticipate. As to amalgamation with any other company, previous efforts had entirely failed; and, for himself, he would rather trust to the prospects of the concern alone than to amalgamation.

The report was then adopted, and the dividend declared in the terms recommended.

CENTRAL AMERICAN TELEGRAPH.

The adjourned general meeting was held on February 23, at the City Terminus Hotel; Mr. J. Heugh presiding.

The report reminded the shareholders that at the last annual meeting in December, 1874, the chairman stated that probably before another year had elapsed the company would have transferred its cables to the West India and Panama Telegraph Company (Limited)—in accordance with the terms of the agreement with that company, which had been submitted to and approved by the shareholders of this company—and this company practically be wound up. The Trinidad-Porto-Rico section of the cable had been completed and handed over to the West India and Panama Company, but the directors regretted to state that that company had refused to accept the Para-Demerara section. Legal proceedings were pending between this company and the contractors in reference to this section.

The Chairman briefly moved the adoption of the report, stating that the affairs of the company being in litigation, and the contractors with the company for the cable being shareholders of the company, he did not think it would be desirable to discuss the company's affairs any further.

Mr. A. Seymour seconded the motion.

The Chairman, in reply to Mr. S. Lewis (of Hooper's Telegraph Works Company), said the company had had no reserve, and had received nothing from traffic. The cables were in such a state that they had not been able to carry enough to pay expenses. He believed some messages had passed through, but the companies working the cables—the West India and Panama and the Western and Brazilian—had the receipts to cover expenses. The gross revenue would, he believed, be under £100.

The reports and accounts were then adopted.

DIRECT SPANISH TELEGRAPH.

The fifth ordinary general meeting of the shareholders of the Direct Spanish Telegraph Company was held at the London Tavern, Bishopsgate-street, on the 21st March, Mr. Niel Bannatyne in the chair.

The Secretary having read the notice calling the meeting, the report was taken as read. It stated that during the last six months the number of telegrams which had passed over the cables of the company was 46,625, against 37,419 in the corresponding six months of 1874. Out of the balance of £7,352 at the credit of profit and loss, £2,779 would be required for the payment of the half-yearly dividend on the 10 per cent. preference shares, leaving the sum of £4,573, out of which the directors proposed paying a dividend at the rate of 5 per cent. per annum upon the ordinary shares, absorbing £2,909, and leaving £1,664 to be carried to the reserve fund.

The Chairman said, in moving the adoption of the report, the directors were in hopes up to a recent period of being able to meet the shareholders with a higher dividend on the ordinary shares, but unfortunately the Lizard-Santander cable broke on the 3rd of last month. It was, however, efficiently repaired on the 27th of the same month, and that cable was now, as well as the one from Barcelona to Marseilles, in excellent condition. The cessation of the war in Spain had rendered it of the greatest importance that they should see to the early establishment of direct communication with Bilbao, so as to get back the valuable traffic they previously had on that line, and which they had for some time been without, owing to the state of matters in the north of Spain.

Mr. Abraham Scott briefly seconded the motion, which was agreed to unanimously, and the dividend at the rate of 5 per cent. per annum on the ordinary shares declared.

INDIARUBBER, GUTTAPERCHA, AND TELEGRAPH WORKS.

The twelfth ordinary general meeting was held on Tuesday, the 14th March, at the City Terminus Hotel; Mr. G. Henderson presiding.

The Chairman, in moving the adoption of the report and accounts, said the trading in the year had been good, and enabled them to write off nearly two-thirds of the amount standing at the debit of profit and loss account, and if they went on at the same rate during the present year—and he thought they would—they would be able to extinguish the balance of £24,182 remaining, and have a surplus available. With regard to the Peru and Chili cables, the receipts of which were good and improving, they had still to complete the remaining link from Caldera to Valparaiso, when the receipts would doubtless improve, and the

cable was well forward in course of manufacture at their works. They hoped to lay it during the year, and this would complete the whole system of the Peru and Chili cables.

Mr. S. W. Silver seconded the motion.

Mr. W. Hancock complained of the small profits made in the year.

The Chairman, in reply, said that, excepting manufactured goods, everything in their stock and trade was taken at cost price. The shares they had in other companies were fairly quotable, and they stood in the books at a fair price only.

The resolution for the adoption of the report and accounts was carried *nem. con.*

INDO-EUROPEAN TELEGRAPH COMPANY.

The report of the Indo-European Telegraph Company states that the receipts for the year amounted to £76,865, an increase of £9,094 over 1874, and the expenditure, exclusive of maintenance charges, was £17,813, an increase of £2,554 on the previous year. There is, after charging £5,798 percentage upon profits to Messrs. Siemens, and adding £383 from the previous year, a balance of £29,636. From this amount is to be deducted £12,202, the balance for erecting the Kertch-Ekaterinodar wire, and the interim dividend of 5 per cent.; in addition to which the directors recommend a dividend to the same amount for the half-year ended December 31. It is also proposed to place £6,000 to a reserve and contingency fund, and to carry over the balance of £809 to the current year.

DIRECT UNITED STATES CABLE.

The report of the Directors of the Direct United States Cable Company for the period ending the 31st of December last has been issued. It reiterates the charges as to the breakages of the cable already alluded to. The Directors say that their receipts during the time their cable was in operation exceeded expectations, and were sufficient to satisfy them of the soundness of the undertaking. There were 48 days, it seems, during which messages were transmitted, and the gross receipts for that time came to £17,051. Seven per Cent. Debentures for £100,000 have been issued to enable the company to meet the expenses, for which the paid-up capital has not proved sufficient.

A circular has been issued by the holders of a large number of shares, urging the desirability of an examination into the transactions of the company, especially with regard to the reparation contracts and the issue of debentures. With regard to the reparations, the circular states that, as all cables are subject to breakages, accidental or otherwise, the providing a suitable repairing ship at the outset, either by purchase or by contract, is essential to success. The accounts of the Anglo-American Company show that the cost of repairing all their six shore cables, although their vessel was constantly employed, only amounted to £9,000 in six months, whereas the Direct Company spent £33,500 for one repair, and if the other two were charged at the same rate the repairs of five months must have cost £100,000. To remedy this neglect of the interests of the shareholders proxies are requested to oppose the adoption of the report, and to ask for the appointment of a committee for the purpose of inquiring into the position of the company, and of negotiating for a sale to the Anglo-American Company, the result to be submitted to an adjourned meeting a fortnight later.

At the general meeting of the shareholders of the Direct United States Cable Company, held on the 28th ult., the report and accounts of the directors were, after a long statement from the Chairman, and a stormy discussion, adopted. It was stated that the three repairs of the Direct Cable cost £75,000, and that the *Faraday* was now engaged at £1,000 a month.

The directors of the Eastern Extension, Australian, and China Telegraph Company (Limited) have resolved (subject to audit) to declare a fourth quarterly dividend of 2s. 6d. per share, making 5½ per cent. for the year ending December 31, 1875.

The half-yearly report of the Eastern Extension Telegraph Company states that the gross earnings amounted to £109,366 14s. 10d., and the working expenses to £41,515 12s. 4d., including £13,209 12s. 11d. for the late repair to the cable. The balance of profit is £67,851 2s. 6d., out of which an interim dividend of 1¼ per cent. has already been paid, and it is now proposed to make a further distribution of 1¼ per cent., which will be the final payment for the year 1875, making 5½ per cent. over that period, and leaving £40,268 16s. to be carried to the reserve. Of the 3,200 debentures sanctioned, 2,649 have been issued, and the proceeds devoted to the laying of the New Zealand cable. The amount was entirely subscribed by the shareholders.

With reference to the notification respecting the interruption of the Madras-Penang cable, the Eastern Telegraph Company (Limited) announce that steamers leave as follows: Galle to Singapore, April 3 and 17; Galle to Penang, April 10 and 24; Rangoon to Penang, April 2, 3, and 13.

Parliamentary Intelligence.

SELECT COMMITTEE ON THE POSTAL TELEGRAPH DEPARTMENT.

In the House of Commons, on March 17th, Mr. J. Goldsmid moved for a select committee to inquire into the results of the Telegraphs. Col. Alexander seconded the motion, and suggested the employment of the Royal Engineers. Dr. Cameron supported the motion, and mentioned the case of the Orkney and Shetland Company, which, he believed, was in a position to defeat the Government monopoly. Lord J. Manners defended Mr. Scudamore. The Chancellor of the Exchequer finally assented to the appointment of a committee, on condition that its objects were strictly limited to matters affecting internal organization. Mr. Goldsmid acquiesced in this, and withdrew his motion on the understanding that the Government will confer with him as to the terms of reference.

SUBMARINE CABLES, March 23.

Mr. Bourke informed Mr. Noel that there are no treaties for the protection of submarine cables

beyond the limits of territorial waters, and as no case of wilful breakage had yet arisen, he could not say what was the law on the subject.

MUNICIPAL OBJECTION TO OVER-GROUND LINES IN AMERICA.

A suit has been brought by the City of Philadelphia to restrain the Western Union Telegraph Company from placing poles in Tenth Street, and to compel the company to run its wires underground. It was argued in the Court of Common Pleas, No. 4, on Monday last, and affidavits from Mr. David Brooks and others showing the feasibility of operating subterranean lines were submitted. A question of fact arose as to whether underground wires in Europe had proved satisfactory. It was alleged on behalf of the defendant that such enterprises had almost invariably been abandoned, while on behalf of the city it was insisted that this was the method now in universal use in Great Britain and continental Europe. The City Solicitor telegraphed to the post office authorities in London early in the day, making inquiries in regard to the matter, and before noon a reply was received and read to the Court.

The following are the despatches referred to:

"Philadelphia, March 6, 1876. Charles T. Fleetwood, Chief Post Ofs. Telegraphs, Gen. Post Ofs., London, E.C.: Will you please inform me, by cable, whether the underground wires in London, referred to in your paper in the *Electrical Review* of January 15*, are in successful and perfect operation, and perform the same and as good service as if erected upon poles, and for how many years have they been performing such service satisfactorily?

"Are telegraph poles in use in the principal streets of London or of any of the cities of Europe?

"In a case at this moment being argued between this city and the Western Union Telegraph Company, the latter contends that underground telegraphy has proved a failure in Europe. Is this so?

"Chas. H. T. Collis, City Solicitor."

"March 6, 1876. Charles H. T. Collis, City Solicitor, Philadelphia: The underground wires in London, referred to in Mr. Fleetwood's recent paper, are in successful operation. It would not be possible to carry the same number of wires through London by overground work, nor would it be desirable, considering the atmosphere; but there are some overground wires which are carried over the housetops. There are no poles in the streets. All the important wires have been carried underground, through London, for the past twenty-five years.

"Pole and underground lines are in use in continental cities. W. H. Winter,

"Assistant Engineer-in-Chief, General Post-office, London, England."

Correspondence.

To the Editor of the Telegraphic Journal.

Sir,—I see, in your number for January 15 last, a description of D'Infreville's duplex arrangement, and beg to inform you that it is identical with one patented by myself in March, 1873. In that patent I described two methods with opposed batteries, of which the one described in your journal is the least advisable; the other, which differs from this just as the ordinary differential system differs from the bridge system, I have had in constant use on the Madras Railway since September, 1873. There are two circuits, of 200 miles each, worked on this system, and they are made to translate when necessary from one circuit into the other. In each circuit there are three intermediate stations which are worked entirely without batteries. My reason for dividing the circuit in the middle is merely to avoid having too many intermediate stations, and not at all owing to any difficulty in working a line 400 miles in length. I cannot understand so large a battery power being required in America. One of my circuits of 200 miles is worked by 20 Leclanché cells at each end, and the other by 36 Daniell's at each end. On the western circuit, in which the line runs along the sea coast for a long distance, I find it necessary to increase the power during the heavy monsoon, but on the eastern circuit, that is from Madras to Salem, the 20 cells are ample during the wettest weather. I send you by book post a pamphlet published in 1873, giving a full description of the methods, and my reasons for considering them better than either of the ordinary systems of Duplex working. I may add that the system was successfully tried on a loop line between London and Bristol, a circuit of 240 miles in length, as early as May, 1873, in the presence of Mr. Culley and other officers of the Postal Telegraph Department. Yours truly,

G. K. Winter,
Telegraph Engineer,
Madras Railway.

Arconum,
18th February, 1876.

[We have carefully examined and compared Mr. Winter's and Mr. D'Infreville's inventions, and the two are undoubtedly identical. We are sorry that want of space will prevent our publishing the contents of Mr. Winter's pamphlet.—Ed. *Tel. Jour.*]

J. Barnes.—We should recommend you to use about six cells of Grove with 6 in. by 3 in. immersed platinums joined up in series, and to connect your six electro-magnets up so as to form a three series of two pairs each. No. 16 wire would do well for the magnets.

We have received a short notice relative to a cable across the River Plate, but as it is unauthenticated by any note or signature, we cannot insert it. Possibly the sender forgot to place in the envelope a letter asking for its insertion, and vouching for its truth. The postmark was Leeds.—Ed. *Tel. Jour.*

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interest to which "The Telegraphic Journal" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the Editor; business communications to the Publishers, 10, Paternoster Row, E.C.

* *Telegraphic Journal and Electrical Review* (No. 71).

* A diagram is here given, showing a leverage of 3 to 1.